

BRIEFER ARTICLES.

THE SEEDLINGS OF *JATROPHA MULTIFIDA* L. AND *PERSEA GRATISSIMA* GÄRTN.

(WITH SIX FIGURES)

TWO MODES of germinating are characteristic of the dicotyledons, with the cotyledons above or under ground. The first is undoubtedly the commonest. In this case the cotyledons, as a rule, are freed from the seed-coat and develop as two, seldom only one or several, leaf-like organs. In the other case, however, the cotyledons either remain enclosed in the seed or become free, but stay under ground. These are the principal forms of germination which Klebs¹ has ascribed to the dicotyledonous orders, and it is interesting to see that both forms may occur not only within allied genera, but even among species of the same genus. Furthermore, the germination itself exhibits a number of biological variations in regard to the relative development of the primary root, the hypocotyl, and the cotyledons. But it would seem very difficult to find any deviation from the rules given above, at least from the first, in which the cotyledons are above ground and free, while the second comprises two possibilities, enclosed or free cotyledons. When the seed-leaves are carried up above ground, this is not necessarily connected with the development of a hypocotyl, nor are the underground seedlings always destitute of such. But when a long hypocotyl raises the seed above the ground and the cotyledons, furthermore, are provided with petioles of considerable length, we should never expect to find the seed-leaves permanently enclosed in the seed and falling off without being exposed to sunlight. It would seem very strange if any such case really existed.

It was, therefore, very surprising to learn that Fr. Müller, in Blumenau, Brazil, had discovered a plant which exhibited this peculiar mode of germinating, the *bicuiba* or *Myristica Bicuhya*, a tree of the primeval forests in Brazil.² The seedling of this tree possesses a long

¹ KLEBS, GEORG: Beiträge zur Morphologie und Biologie der Keimung. Untersuch. aus d. Botan. Inst. Tübingen 1: 536-635. 1885.

² MÜLLER, FR.: Keimung der Bicuiba. Berichte d. deutsch. botan. Ges. 5:468. 1887.

hypocotyl and two deeply lobed cotyledons, which, although above ground, do not leave the seed. To this instance may, however, be added a second, but of an order very remote from the Myristicaceæ.

A few weeks ago Mr. G. W. Oliver, of the botanical garden at Washington, D. C., called my attention to some very odd-looking seedlings of *Jatropha multifida*, which were kindly submitted to the writer for closer study. The germination of this plant had, so far, only been very briefly mentioned by Sir John Lubbock,³ who merely recorded it as an exception from that of the other Euphorbiaceæ. The seedling develops as follows.

Next to the primary root the hypocotyl increases very considerably in length and penetrates the soil by making a strong curvature until the seed becomes raised above ground, while simultaneously the petioles of the cotyledons have reached their final development and attained a very considerable length. While the hypocotyl increases rapidly in length and thickness, the cotyledons show no signs of becoming freed from the seed-coat. The plumule begins to develop a distinct internode, and the first leaves, being opposite and of approximately the same shape as the later ones, appear a short time before

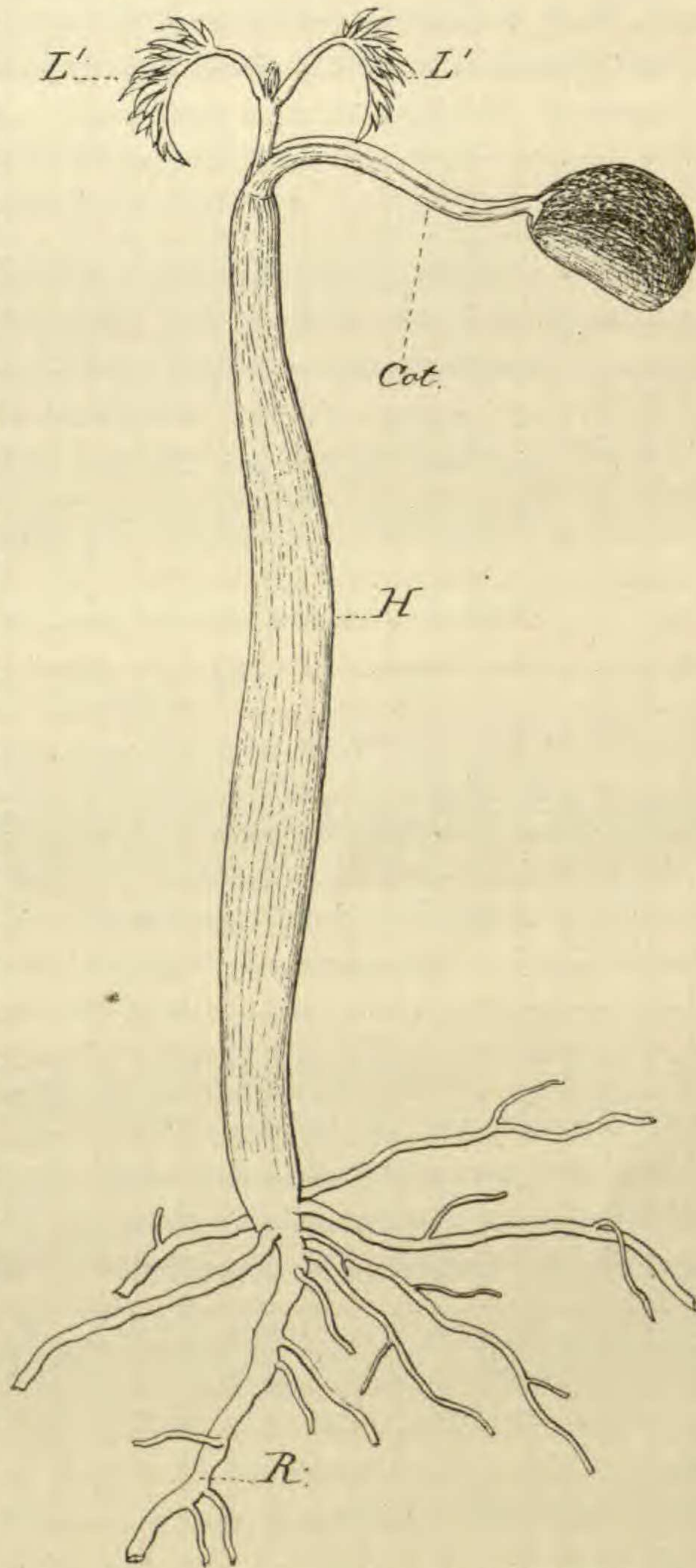


FIG. 1.—Seedling of *Jatropha multifida* L.; natural size.

³ LUBBOCK, J.: Seeds and seedlings.

the cotyledons drop off, with their leaves still enclosed. The accompanying drawing (*fig. 1*) illustrates a seedling with the cotyledons, *Cot*, attached, and the first leaves, *L*¹, almost expanded. The primary root, *R*, is persistent and branches very soon, while a few secondary ones proceed from the base of the hypocotyl. The very long and thick hypocotyl, *H*, is green and glabrous; there is an early development of cork-layers; the bark-parenchyma is broad and traversed by a number of laticiferous ducts. The mestome bundles are of normal structure and between these are numerous strata of interfascicular cambium. A pith occupies the center of the hypocotyl; its cells are like those of



FIG. 2.—
Blade of a

the lower. Along the ribs on the upper face, two kinds of cotyledon; hairs are visible. These are either long, multicellular, and pointed, or unicellular and almost globular in shape. The latter (*fig. 3*) are quite abundant in contrast to the first, and in some places they covered the surface just above the ribs. They represent glandular hairs, but their function could not be ascertained. The lower surface of the blades, which lie close up to the endosperm, is wholly glabrous. A typical palisade tissue was observed, covering a rather dense pneumatic tissue, and both contained abundant deposits of starch; laticiferous ducts were also very frequent.

This seedling has no mate among the other species of *Jatropha*, which have been studied heretofore. Sir John Lubbock figures and describes *J. Curcas* L. and *J. podagrica* Hook., both of which possess stout and long hypocotyls; furthermore, their cotyledons are free and provided with distinct petioles, although not equaling in length those of *J. multifida*.

Another and very peculiar manner of germinating was observed in *Persea gratissima* Gärt., of which several seedlings were cultivated at

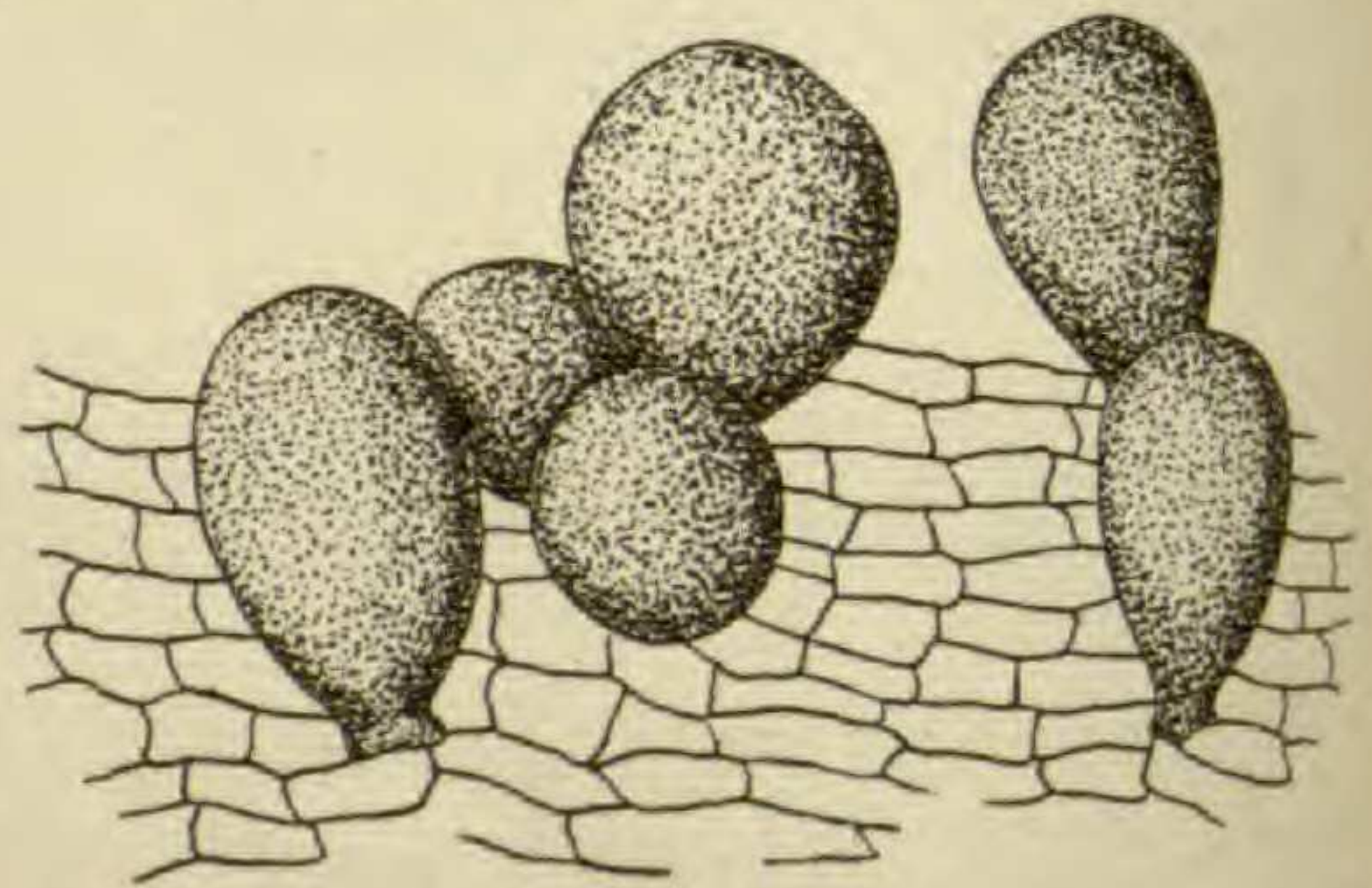


FIG. 3.—Epidermis with glandular hairs from the cotyledons of *Jatropha multifida*.
× 240.

the same time in the botanical garden at Washington, D. C. It is strange that the Lauraceæ have been almost entirely passed by in works dealing with seedlings, none having been recorded either by Klebs (*l. c.*) or Sir John Lubbock (*l. c.*). Schacht⁴ appears to be the only author who has given us some information about them; he states that the seed of *Persea gratissima* germinates while the fruit is still attached to the tree. This author observed, also, that in this species of *Persea* the plumule attains a very early development with a number of leaves, similar to *Juglans* and *Tropæolum*. Having detected a few other peculiarities connected with the germination of *Persea*, and having been unable to find any figure of this, I take this opportunity to publish and illustrate my observations, together with the still more remarkable case of germination just described.

In *Persea gratissima* there is no endosperm, and the large cotyledons remain enclosed by the seed-coat. No hypocotyl develops during the germination, but the plumule grows out very soon as a shoot with several leaves, while the primary root at the same time has attained a considerable length and developed a number of very strong lateral roots arranged in whorls of from three to five or more. In the accompanying drawing (*fig. 4*) the plumule has developed as a single shoot, and it is very strange to notice that the very first four leaves, L^1 , are not only opposite, but even provided with petioles and blades, thus imitating the typical leaf of this species. On the other hand, the succeeding five or

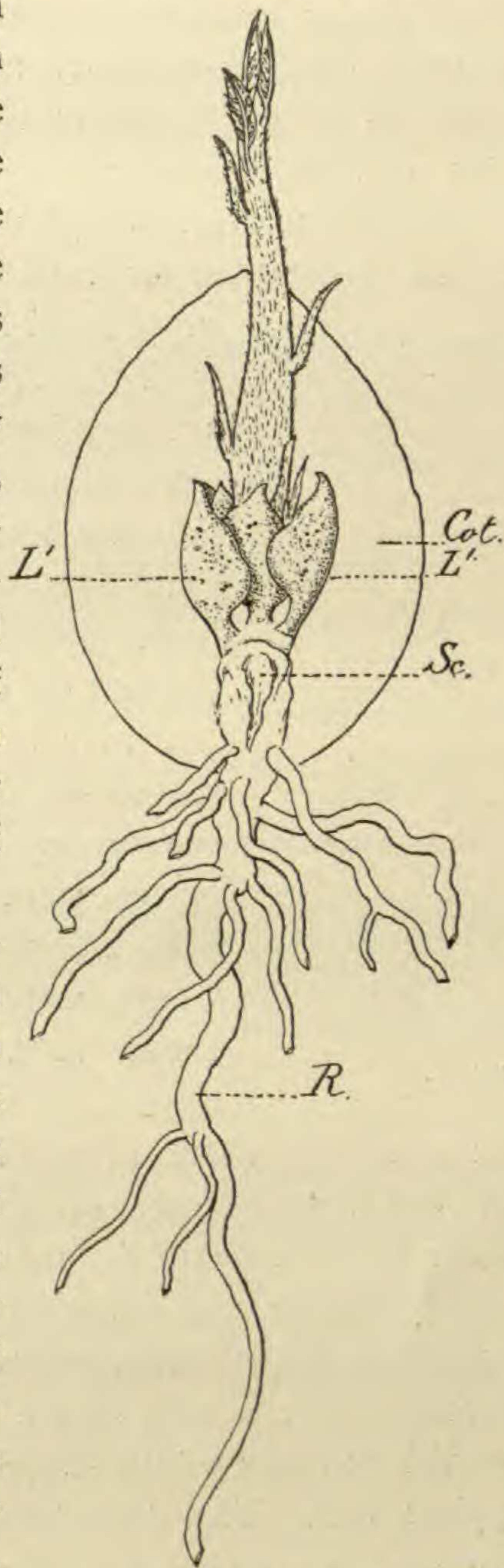


FIG. 4.—Seedling of *Persea gratissima* Gärtn., natural size. *R* primary root; *Sc*, scar from the removed cotyledon; *Cot*, the other cotyledon; L^1 , the first leaves.

⁴SCHACHT, HERMANN: Lehrbuch der Anatomie und Physiologie der Gewächse 2: 447, 468. 1859.

six leaves are almost scale-like, with no petiole or blade, but covered with silky hairs like the axis and the proper leaves when young. Thus *Persea gratissima* demonstrates the fact that in seedlings with enclosed cotyledons, there may be an alternation of various forms of leaves, while in *Juglans* and *Carya*, for instance, all the first leaves are scale or bristle-like.

When, however, the plumule does not develop as a single shoot but as a complex of ramifications, the first leaves become almost suppressed and appear only as small and rather broad scales (*fig. 5*). In this case, the shoots have pushed out very freely from the axils of the lowest leaves, and have almost attained the same development as the plumule itself, possessing elongated internodes and some narrow scalelike leaves with silky hairs. Besides these lateral branches, there is a bud observable in the axil of each of the two cotyledons (*fig. 6*), which is evidently ready to develop if the mother-shoot, the plumule, should become injured. The first developed leaves were perfectly glabrous, in contrast to the succeeding ones.



FIG. 5.—Plumule of seedling of *Persea gratissima*; natural size.

There were a few stomata on the lower surface, but none on the upper. The mesophyll formed a homogeneous tissue filled with starch, and there was no indication either of collenchyma or stereome above or underneath the mestome bundles.

In *Lindera* and *Sassafras*, at least in their North American representatives, the germination takes place underground, but the plumule develops as a single shoot. The first leaves are bristle-shaped, succeeded by a few whose shape is approximately the same as that of the typical leaf. The three-lobed leaf of *S. officinale* Nees, however, is only seldom observed in the first year of the seedling, those developing at this stage being ovate and entire.—THEO. HOLM, *Brookland, D. C.*

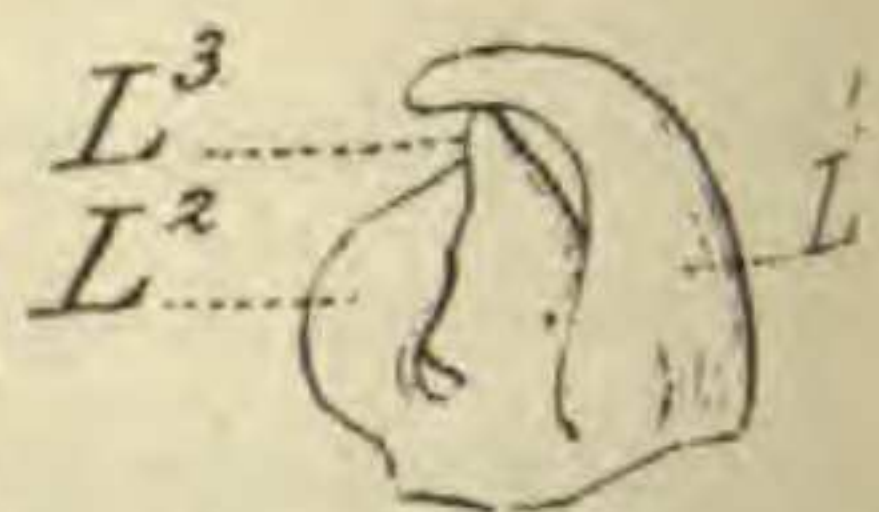


FIG. 6.—A bud from the axil of a cotyledon of *Persea gratissima*. L^1 , L^2 , L^3 , the first, second, and third leaf; magnified.